

# **DEFENSE ANALYSIS CHALLENGES FOR MODELING AND SIMULATION**

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# LISTEN TO THE EVOLVING LANGUAGE OF THE DEFENSE DEBATE

-“ASYMMETRIC” THREATS.

-“UNCERTAINTY” AND “CHANGE”.

-EFFECTS BASED WARFARE.

-PRECISION ENGAGEMENT.

•“UNINTENDED CONSEQUENCES”.

-SYNCHRONIZING ALL INSTRUMENTS OF NATIONAL POWER TO  
ACHIEVE A DESIRED END STATE.

•VARIETIES OF MOTIVATIONS & CAPABILITIES.

-ADAPTIVE THREATS.

- INFORMATION BASED WARFARE.

-EMERGENT BEHAVIOR.

THE LANGUAGE OF “OPEN SYSTEMS”.

THE LANGUAGE OF COMPLEXITY SCIENCE.

BEHAVIORS, SYSTEMS, STRUCTURES EMERGE FROM  
INTERACTIONS AMONG INGREDIENTS; THEY ARE  
“CONSEQUENCE” MORE THAN “CAUSE”.

# OPEN SYSTEMS

- **THERMODYNAMICALLY, ENERGY CROSSES THE SYSTEM BOUNDARY.**
  - “ENERGY” INCLUDES MENTAL ENERGY:
    - INFORMATION, CREATIVITY, PERCEPTION, MOTIVATION.
- **STRUCTURE & BEHAVIOR “EMERGES” - ATTRACTORS**
  - WHAT WE SEE AS “SYSTEMS” APPEAR AND ENDURE AND CAN CHANGE THEMSELVES TO SATISFY MOTIVATIONS ABILITIES AND OF THEIR INGREDIENTS. .
- **CHARACTERIZED BY STATE CHANGES: LIKE WATER**
  - **FIXED** (SOLID) - “LOCKED” STRUCTURE.
    - TRADITIONAL, NEWTONIAN, ANALYSIS METHODS APPLY.
  - **BOUNDARY** (LIQUID) - EMERGENT BEHAVIOR “WHIRLPOOLS”
    - COMPLEXITY SCIENCE.& OPEN SYSTEMS ANALYSIS METHODS.
    - ADAPTATION, EVOLUTION, CHANGE.
    - STRUCTURES EXHIBIT, HOMEOSTASIS, RESILIENCE.
  - **CHAOS** (GAS) - “EXTREME SENSITIVITY” TO INITIAL CONDITIONS.
    - FLAPPING BUTTERFLY WINGS → TORNADOES

# **WARFARE**

## **A COMBINATION OF “OPEN & CLOSED” PARADIGMS**

- **COMMAND AND CONTROL & COMMUNICATIONS.**
- **“FOCUSED LOGISTICS” & TPFDD AND DEPOT  
BASED LOGISTICS.**
- **FORCE PLANNING FOR “ADAPTIVE” THREATS.**
  - **“THREAT” vs “CAPABILITY” BASED FORCE DESIGN.**
  - **“SCENARIOS” vs CO-EVOLVING FITNESS LANDSCAPES.**
- **BUDGET PLANNING.**
  - **“KNAPSACK” PROBLEM vs. SURVIVAL & ADAPTATION  
ON AN EVOLVING FITNESS LANDSCAPE.**

# STATE OF DEFENSE ANALYSIS METHODOLOGY

- DOMINATED BY LEGACY OF THE “CLOSED SYSTEM” PARADIGM.
  - “NEWTONIANISM” DETERMINISTIC CAUSE & EFFECT.
  - “REDUCTIONISM” DISASSEMBLE THE WHOLE, UNDERSTAND THE PIECES, REASSEMBLE TO UNDERSTAND THE “WHOLE”.
- USE OF “REALISM PAINT” TO MAKE A “CLOSED” MODEL LOOK MORE “REALISTIC”.
  - STOCHASTICS TO FUZZ THE BEHAVIOR
  - MORE DETAIL; THE ENDLESS QUEST.
- INCREASED USE OF GAMING AND FACILITATED SEMINARING IN COMBINATION WITH CLOSED PARADIGM M&S.
  - CAPTURE EMERGENT BEHAVIORS & UNINTENDED CONSEQUENCES
  - M&S USED HERE FOR “ACCOUNTING” AND “KINEMATICS”.
- BEGINNINGS OF A MILITARY COMPLEXITY SCIENCE.
  - AGENT BASED SIMULATION- PROJECT ALBERT, USMC.

# **EXAMPLE**

## **CLOSED vs OPEN SYSTEM**

### **ANALYSIS**

**WWII SUBMARINE SEARCH:**

**THE “SYSTEM” = GERMAN ATLANTIC SUBMARINE OPERATIONS.**

**REAL WORLD SUBMARINE PRESENCE PERCEIVED WITH:**

- RADIO REPORTS ATTRIBUTABLE TO SPECIFIC SUBMARINES.**
- UNATTRIBUTABLE RADIO TRAFFIC FROM SUBS.**
- TORPEDO HITS ON CONVOYS.**
- RECCE & INTEL FROM SUB BASES .**
- PHYSICS OF SUBMARINE PERFORMANCE.**
- INTEL AND EXPERTISE ON SUBMARINE ORGANIZATION, OPS, ROE.**
- GOOD KNOWLEDGE OF MY OWN SENSING CAPABILITIES.**

**LOTS OF ENERGY FLOWING FROM THE SYSTEM: **OPEN****

**SYSTEM HAS GOALS & MOTIVATIONS; STRUCTURE, IT BEHAVES & EVOLVES.**

# **CLOSED SYSTEM ANALYSIS APPROACH**

**QUESTION: HOW MANY SUBS ARE DEPLOYED?**

**APPROACH: DEFINE A **CLOSED** SYSTEM AND PREDICT  
ITS CHARACTERISTICS.**

**-CLOSED SYSTEM:**

- USE ONLY THE RADIO REPORTS ATTRIBUTABLE TO  
SPECIFIC BOATS.**
- IGNORE THE REST OF THE ENERGY PASSING THROUGH  
THE SYSTEM, (THE SIGNATURES OF THE REAL SUBMARINE  
OPERATING STRUCTURE)**
- ASSUME A POISSON DISTRIBUTION. (UNIFORMITY ASSUMED)**  
**5 SUBS REPORTED 1 TIMES.**  
**3 SUBS REPORTED 2 TIMES**  
**2 SUBS REPORTED 3 TIME.**

**PREDICTIONS: THERE ARE 2 SUBS NEVER HEARD/ 12 SUBS TOTAL.**

**NEXT QUESTION:HOW DO WE BEST FIGHT THESE SUBS??**

**-HEART & SOUL OF **EFFECTS BASED WARFARE  
ANALYSIS.****



# **OPEN SYSTEM ANALYSIS APPROACH**

## **AGENT BASED SIMULATION.**

- TREAT CONVOY SHIPS AS “AGENTS (SCRIPTED)”**
- DEFINE SUB “AGENTS”. (TUNE DETAIL FOR REALIST BEHAVIOR)**
- USE GENETIC ALGORITHMS TO “BREED”SUBMARINE FORCES AND OPS CONCEPTS**
  - SUB CHARACTERISTICS ( PRETTY GOOD BOUNDARIES)**
  - C2 STRUCTURE (REPORTING RULES)**
  - MOTIVATIONS (SINK SHIPS & DON/T GET SUNK)**
  - OPS CONCEPTS (CRUISE DURATION, REPLACEMENT SCHEMES ,OPS AREAS)**
- AS SUB OPERATING STRUCTURES EMERGE FROM SUB AGENT INTERACTIONS WITH CONVOYS,SEARCH EFFORTS, PHYSICS, ETC)**
- TEST THOSE EMERGENT SUBMARINE “STRUCTURES”.**
  - COMPARE ITS PERCEIVABLE “SIGNATURES” (RADIO TRAFFIC, TORPEDO HITS, PORT INTEL REPORTS, ETC) TO REAL EXPERIENCE.**
- OBSERVE “BEST FIT”OF AGENT MODEL TO REALITY**
- NOW SPECULATE ON: HOW MANY, HOW TO FIGHT.**

# CLOSED vs OPEN SYSTEM COMPARISON

## **CLOSED** SYSTEM APPROACH:

- DEFINED A STRUCTURE; ITS SHAPE & BEHAVIOR- OUR “MODEL”.
- CLOSED THE BOUNDARIES OF OUR INVESTIGATION.
  - WORKED WITH A FIXED SUBSET OF THE INFO AVAILABLE
  - IGNORED DATA THAT DID NOT FIT THE “MODEL”.
- LEARNED VERY LITTLE OF WHAT THERE WAS TO KNOW ABOUT GERMAN SUBMARINE BEHAVIOR.
- WE FIT THE WORLD TO OUR DESIGN; NOT ASKING WHAT MIGHT BEST EXPLAIN WHAT WE WERE SEEING; USING ALL OF WHAT WE WERE SEEING; NOT CONSIDERING HOW IT MIGHT RESPOND TO SOMETHING WE MIGHT DO

## **OPEN** SYSTEM APPROACH:

- LET A STRUCTURE “EMERGE” FROM THE POSSIBLE INTERACTIONS.
  - “SELF ORGANIZATION”- IT DEFINES ITS “BEST” SELF.
- USE ALL THE INFORMATION AVAILABLE TO TEST EMERGENT STRUCTURE.
- HAVE A TOOL FOR UNDERSTANDING THE “WHOLE” OF THE ENEMY OPS AND WHAT MIGHT HAPPEN NEXT--EXPLORE ADAPTIVE BEHAVIOR.
- HAVE A METHODOLOGY FOR **EFFECTS BASED WARFARE** ANALYSIS.

# CHALLENGES

- WHAT IS THE **VALUE** OF ANALYSIS OF “OPEN SYSTEM” ISSUES PERFORMED WITH CLASSIC “CLOSED SYSTEM” METHODOLOGY?

HOW DO WE **RECOGNIZE, DESCRIBE& ANALYZE** “OPEN SYSTEM” ISSUES?

- WHAT IS IMPORTANT TO **KNOW** ABOUT “OPEN” MILITARY SYSTEMS BEHAVIOR?
- WHAT CAN WE REASONABLY **TELL** DECISION MAKERS ABOUT “OPEN” PROCESSES AND THEIR CONSEQUENCES?
- WHAT CAN WE LEARN FROM **COMMERCIAL USES** OF COMPLEXITY SCIENCE & OPEN SYSTEM ANALYSIS?
- WHAT IS THE “**RIGHT WAY**” TO USE THE COMPUTER?
  - AGENT BASED SIMULATION
  - BREEDING & TESTING STRUCTURES vs DEFINING “THE SYSTEM”.